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ASPECTS OF LIFE HISTORY, ECOLOGY, AND DISTRIBUTION OF THE ASIATIC FOUR-LINED SKINK, *EUMECES QUADRILINEATUS*, IN SOUTH CHINA

JAMES LAZELL[1] AND HIDETOSHI OTA[2]

ABSTRACT. The life history of *Eumeces quadrilineatus* in South China appears correlated to the southwest, wet monsoon. Females with a snout–vent length (SVL) greater than 71 mm contain shelled eggs in late March and lay clutches of two to six eggs in May, the beginning of the monsoon. Hatchlings appear in late June and early July, measuring 25–33 mm SVL, and grow to at least 51 mm, possibly 58 mm, SVL by early October, the end of the monsoon. Mature size is attained during their second monsoon season, but females probably do not lay eggs until the beginning of their third at ca. 34.5 months of age. Most common in the coastal zone, this species may occur to ca. 500 m in open areas. Tai Yue Shan (Lantau Island), Shek Kwu Chau, and Kau Sai Chau are new islands of record.

> An uncommon skink except on the southern part of Cheng Chau . . . . Elsewhere . . . if any are seen, the numbers are generally small.
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> —Karsen, Lau, and Bogadek (1986)

INTRODUCTION

The Asiatic four-lined skink, *Eumeces quadrilineatus* (Blyth, 1853) is little known and apparently rarely encountered except

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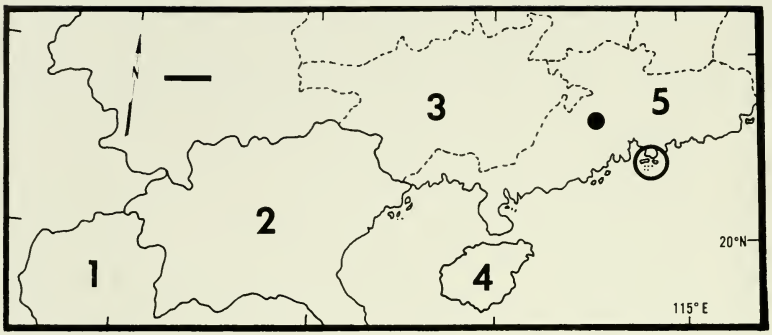

Figure 1. A generalized range of *Eumeces quadrilineatus* from the literature. 1, Thailand, "Siam" of Pope (1935). 2, northern Vietnam, "Tonkin" of Pope (1935). 3, Guangxi (Zhao and Adler, 1993). 4, Hainan, "mountains south of Nodoa" (Pope, 1935). 5, Guangdong; dot indicates Dinghushan, for MCZ 170517; circled area is detailed in Figure 2. Bar is 200 km.

on some continental shelf islands in tropical China. Pope (1935) examined only 13 specimens, of which but six came from China: three from Dinghushan ("Tinghushan"), Guangdong; one from south of Nodoa, Hainan Dao; and two from Hong Kong. Zhao and Adler (1993) include Guangxi within the range, between Guangdong and Tonkin, North Vietnam (Fig. 1). Karsen *et al.* (1986) recorded the species on Cheung Chau island just southwest of Hong Kong, Lazell (1988) on Tai A Chau, Soko Islands, also in Hong Kong Territory, and Lazell *et al.* (1997) on Wai Ling Ding in the Wanshan archipelago, Guangdong Province (Fig. 2).

The closest relatives of *Eumeces quadrilineatus* live not in Asia but in North America. Taylor (1935) placed it closest to *E. egregius* of Florida, Georgia, and Alabama, whereas Lieb (1985) allied it with the *E. skiltonianus* group of western North America. A study of its karyotype by Kato *et al.* (1998) did not include comparison to *E. egregius* and, although no differences were determined from the *skiltonianus* group, the 2n = 26 configuration is typical of the *Pariocela* section of the genus. The relationships of *Eumeces quadrilineatus* will probably only be resolved biochemically. It is biogeographically notable that *Eumeces quad-*

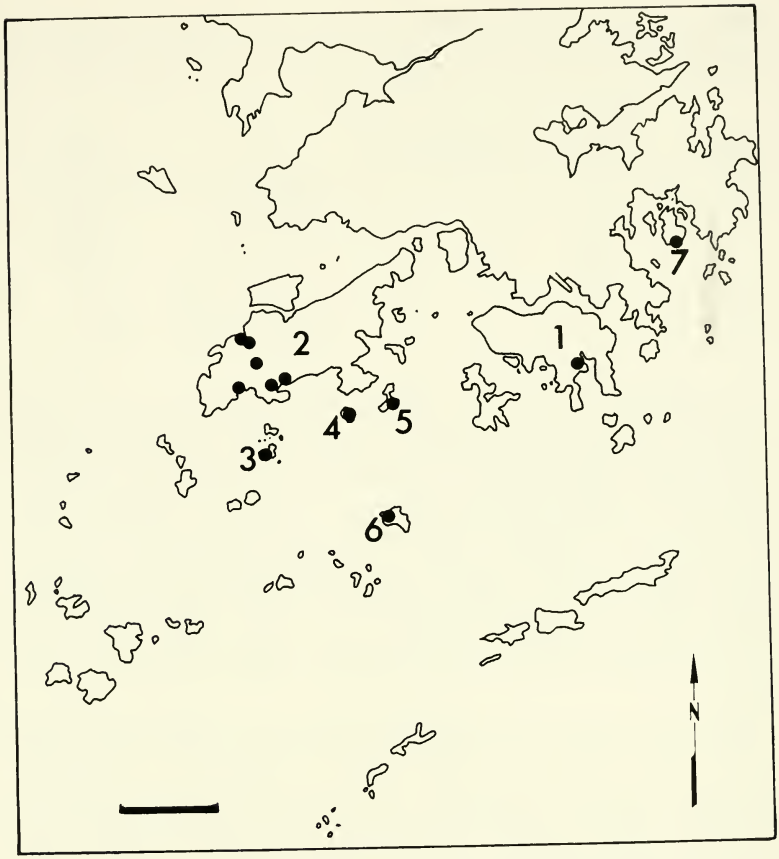

Figure 2. The Wanshan archipelago and Hong Kong region. Dots indicate localities for *Eumeces quadrilineatus* examined in the present study. Islands are: 1, Hong Kong. 2, Tai Yue Shan (Lantau). 3, Tai A Chau, Soko Islands. 4, Shek Kwu Chau. 5, Cheung Chau. 6, Wai Ling Ding. Most of the Wanshans, south and west, are virtually unexplored herpetologically. Bar is 10 km.

rilineatus is one of the few tropical species in Asia fitting a clearly trans-Beringian pattern of relationship (Lazell and Lu, 1999).

LIFE HISTORY

Hosono and Hikida (1999) reported two captive females that laid a total of five eggs, four of which hatched (Table 1 and Fig.

TABLE 1. FEMALE *EUMECES QUADRILINEATUS* AND CHARACTERISTICS OF THEIR EGG CLUTCHES.

Specimen	Snout–vent length	No. eggs	Length (mm)	Width (mm)	Date	Condition
MCZ 172787	72	4	9–11	6	27 March 1987	Oviductal, shelled
MCZ 172788	77	6	5.5–6	5–6	25 March 1987	Oviductal, shelled
KUZ 45250	75	2			14–17 May 1997	Laid
KUZ 45251	73	3			18 May 1997	Laid

3). Both females were from the Cheung Chau population: Kyoto University Museum of Zoology (KUZ) 45250-1. Another Cheung Chau female, Museum of Comparative Zoology (MCZ) 172787, contained four shelled eggs, and one from Tai A Chau, Soko Islands, MCZ 172788, contained six; both lizards were collected in late March (Table 1). Two Cheung Chau females contained large ovarian follicles: KUZ 36508, collected 26 September 1996, had a maximum follicle diameter of 5.3 mm; KUZ 30397, collected 4 October 1994, had a maximum follicle diameter of 3.0 mm.

By far the largest specimen examined is an adult male, KUZ 39301, with a snout–vent length (SVL) of 86 mm, collected on Cheung Chau. The 10 largest males are 70–86 mm (average 75 mm) SVL. Females are slightly smaller: the largest, MCZ 177079 from Shek Kwu Chau, is 79 mm SVL. The 10 largest females are 67–79 mm (average 72 mm) SVL. The difference between the sexes is not significant given our sample sizes. Determining sex usually requires dissection and is uncertain with small specimens. Thus, in the ontograph (Fig. 3) we have not separated the sexes.

Hatchlings grow rapidly during their first wet monsoon season at an average rate of at least 0.22 mm/day, or 1 mm every 4.5 days, calculating from the ontograph (Fig. 3) and assuming similar hatching times and growth rates in different years. Such an assumption is hazardous (see below). Growth might be even more rapid, depending on the ages of the specimens. Three specimens

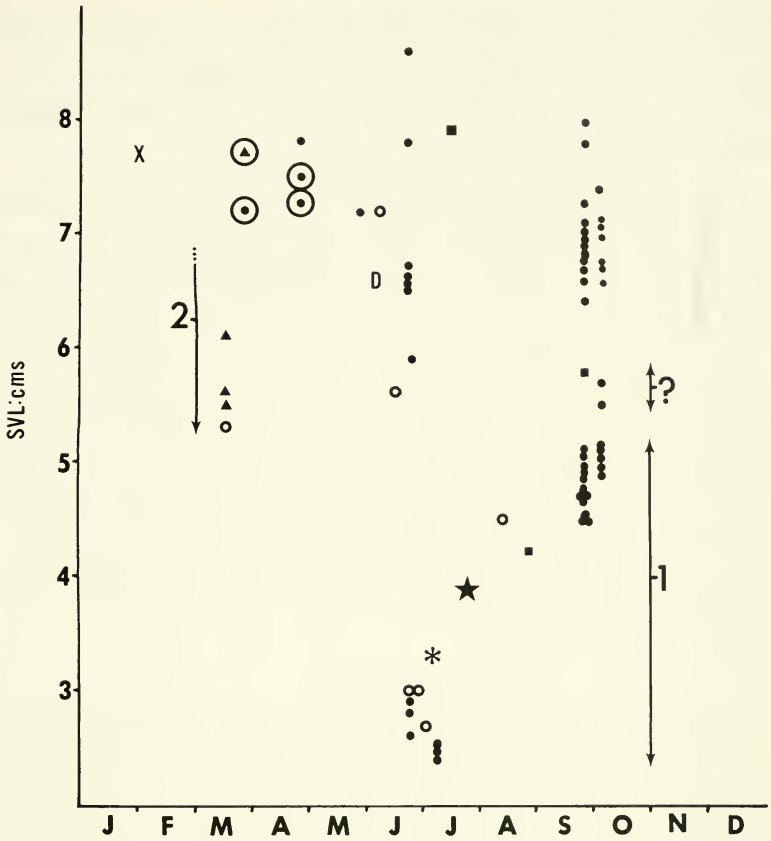

Figure 3. Ontograph of *Eumeces quadrilineatus*. Arrows indicate: 1, range of first wet monsoon growth, and 2, specimens entering their second growth season. The question-marked range includes specimens of uncertain age (see text). Symbols identify populations on different islands: Solid dots, Cheung Chau. Small circles, Tai Yue Shan (Lantau). Triangles, Tai A Chau, Soko Islands. Squares, Shek Kwu Chau. Asterisk, Kau Sai Chau. Star, Wai Ling Ping. D, Dinghushan. X, Hong Kong. The four gravid females are circled (see text).

collected 26 September 1991 (MCZ 176655) and 4 October 1994 (KUZ 36163 and 36168) were 58–55 mm SVL. Because these specimens fall within the range of those collected in March, which must be ca. 8.5 months old, we cannot be certain they are only ca. 90 days old (Fig. 3, but see below).

The circumstantial evidence of size and reproductive condition implies that during their second wet monsoon season, growth slows to about one-third that of the first season to ca. 0.08 mm/day, or 1 mm every 12.5 days. Most specimens can apparently attain ca. 70 mm SVL during their second season. However, because most females this size have ovaries containing small follicles (<2 mm) and thin oviducts, we believe no females reproduce until the next year at about 22.5 months. We believe most breeding females are likely to be even older, ca. 34.5 months, because all six certainly reproductive specimens we have examined (i.e., those with vitellogenic ovarian follicles larger than 2.5 mm or oviductal eggs at capture) were 71–78 mm (average 74 mm) SVL (MCZ 172787-8; KUZ 54250-1, 30397, and 36508).

We hazard the guess that the 86-mm male, KUZ 39301, was at least 4 years old (Fig. 3).

ECOLOGY

Dudgeon and Corlett (1994) provide a comprehensive and concise overview of the climate of the coast of tropical China. Basically and modally, little rain falls in December, January, and February. Average daily temperatures during these 3 months are typically below 20°C. Rainfall increases March to May and usually exceeds 200 mm/month by June. Temperatures increase concordantly to rather consistently exceed 20°C. Warm, wet conditions prevail through September into early October. All of this is the result of the monsoonal wind directions superimposed on the northeast trade wind regime of this latitude. Initially, in October, the northeast monsoon is the trade wind, unaltered by the Eurasian continent. As the continental interior cools, colder, denser air flows outward and the winds shift to dry northerlies. With the advent of continental, temperate spring, the warmed air rises, drawing in a wind off the South China Sea to the southwest. As the wet monsoon progresses through the "summer" months, the

winds shift progressively to southerlies, and eventually southeasterlies, until the cycle repeats itself.

For small reptiles like skinks, virtually all growth must take place during the warm, wet, summer monsoon from May to October. This is the case with the skink *Scincella modesta* (Lazell *et al.*, 1997), but that small species can attain adult size in a single season. The much larger *Eumeces quadrilineatus* certainly requires two seasons to reach adult size (Fig. 3).

Dudgeon and Corlett (1994) also provided detailed data on the vicissitudes of temperature and rainfall among years. Some of their data bear directly on our problem of aging September–October skinks 55–58 mm SVL. Could MCZ 176655, 58 mm SVL, collected 26 September 1991 on Shek Kwu Chau, be only ca. 90 days old? Dudgeon and Corlett (1994:10) showed that the wet monsoon of 1991 was notably late-shifted with monthly rainfall averages ca. 300 mm from June through October. If MCZ 176655 was only ca. 90 days old in late September, it might have grown considerably more had it survived another 30 days.

By contrast, MCZ 172791 (53 mm SVL) collected on Tai Yue Shan (Lantau) 16 March 1987 and MCZ 173399 (56 mm SVL) collected on Tai A Chau, Sokos, 27 March 1987 are the smallest among the presumptive second-year specimens. Dudgeon and Corlett (1994:10) show that the preceding 1986 wet monsoon peaked in July. Rainfall averages dropped well below 300 mm in both August and September and dropped below 100 m in October.

It has been reported that in tropical regions the abundance of insects, the principal prey of skinks, is influenced by precipitation (e.g., Auffenberg and Auffenberg, 1989, and references cited therein). Thus, monsoon conditions may well account for apparent growth discrepancies in *Eumeces quadrilineatus* through fluctuations in prey abundance from year to year.

DISTRIBUTION

Eumeces quadrilineatus is most often found in the early seral stages of terrestrial succession just inland from the sea. This species is also occasionally found in disturbed, early seral stage habitats higher and further inland. The fact that these skinks are almost always found under cover and are rarely observed in the

open or basking contrasts with their predilection for open habitats depauperate in vegetation. We have never found *Eumeces quadrilineatus* in forest.

Coastal wrack, exposed rock and junk piles, and old buildings are the most frequent habitats of *Eumeces quadrilineatus*. Karsen *et al.* (1986:63) say "in areas adjoining woodland," which was the case for MCZ 179529 collected under junk at the fungshui woods edge at Kau Sai village, Kau Sai Chau, 5 July 1994. The large adult MCZ 177079 was captured inside an infrequently used storage building on Shek Kwu Chau; MCZ 179461 was captured inside an abandoned, collapsing building on Wai Ling Ding (Lazell *et al.*, 1997); MCZ 170517 was found inside a little concrete hut at the top of Shan Bao Feng, 491 m elevation, in Dinghushan, Guangdong.

On Tai Yue Shan (Lantau), concrete catchwaters have yielded MCZ 176223 at Ma Po Ping and MCZ 177078 at Shek Pik, both ca. 100 m elevation. Another Tai Yue Shan specimen, MCZ 181781, a 30-mm SVL hatchling, was found dead on the road at the inland edge of Sham Wat Wan village beside an abandoned paddy.

The early seral stage and edificarian habitats of *Eumeces quadrilineatus* are enigmatic in view of its seemingly relictual distribution. This species is regularly encountered only on continental shelf islands like Tai A Chau, Shek Kwu Chau, and Tai Yue Shan. It is, however, vouchered present on only seven islands (Fig. 2), and is nowhere abundant except on one: Cheung Chau, Hong Kong region.

Cheung Chau is largely urbanized and the remaining open spaces need to be given special conservation consideration, if only to preserve the mother lode of disjunct, peculiar *Eumeces quadrilineatus.*

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